DEPARTMENT OF PHYSICS & ASTRONOMY
at
THE UNIVERSITY OF MISSOURI-ST. LOUIS

FACULTY RESEARCH

(Updated: August 1, 2011)

Here is a brief description of the research activities in which the faculty in Physics and Astronomy are involved.

SONYA BAHAR

I apply the physics of nonlinear dynamics and complex systems to the study of collective biological phenomena. My most recent work involves the development of models for the process of speciation in biological evolution. I am particularly interested in how (1) parameters such as mutation rate affect the dynamics of speciation, (2) how evolutionary processes can be characterized using the statistical physics of non-equilibrium phase transitions, and (3) how physics-based approaches can be used to gain insight into the problem of multi-level selection. Other research projects in my group include computational and experimental studies of neural synchronization. Experimentally, we have used voltage-sensitive dyes in order to investigate neural synchronization during focal seizures in the rat neocortex. Computationally, we use nonlinear dynamical models to study the onset and breakup of synchronization in arrays of coupled neurons, and to characterize eye-target synchronization in traumatic brain injured patients.

Recent Publications:

- Contreras, R., Ghajar, J., Bahar, S. and Suh M. Effect of cognitive load on eye-target synchronization during smooth pursuit eye movement. Brain Research 1398:55-63, 2011.
- Dees, N.D. and Bahar, S. Mutation size optimizes speciation in an evolutionary model. PLoS ONE 5(8): e11952, 2010.
- Dees, N. D., Hofmann, M. and Bahar, S. Physical constraints and the evolution of different foraging strategies in aquatic space. Animal Behavior 79(3): 603-611, 2010.
- Dees, N. D., Bahar, S. and Moss, F. Stochastic resonance and the evolution of Daphnia foraging strategy. Physical Biology 5(4):44001, 2008.

BERNARD FELDMAN

My research interests are in physics education, in particular, in the development of new educational materials for introductory physics classes at the high school, college and university level that create excitement and enthusiasm for physics. Recent physics education papers include: "The Collapse of the I-35W Bridge in Minneapolis," [The Physics Teacher, 48, 541 (2010)], "London Bridge's Wobble and Sway" [Physics Today, March 2010. p. 8] "An Introduction to the Solar Cell [The Physics Teacher 48, 306 (2010)] "The Hybrid Automobile and the Atkinson Cycle" [The Physics Teacher 46, 451 (2008] and "The Physics of Bird Flight: An Experiment [The Physics Teacher 46, 155 (2008)]. I have also been writing a number of book reviews including ones on "On Fact and Fraud" by David Goodstein [Physics Today, July 2010 p. 50 and November 2010. p. 11] and "Pursuing Power and Light: Technology and Physics from James Watt to Albert Einstein," by Bruce J. Hunt [American Journal of Physics 79, 687 (2011)]. Finally, I published a letter "Fraud Could Be More Common than Thought" in the APS News (August/September 2010).

RICARDO A. FLORES

My research interests are astrophysical cosmology and applications of quantum field theory to the physics of elementary particles. Cosmology is now a well established branch of science thanks in great part to the astounding diversification of Astronomy in the last three decades into observations covering a very broad range of the electromagnetic spectrum. It is also a very exciting field of research due to its inherent intellectual

appeal, and the rapid progress allowed by a steady flow of observational data. My most recent published work was an analysis of large samples of dark matter halos from cosmological simulations to work out their expected properties in the concordance Cold Dark Matter cosmology with dark energy, which is currently favored by a large body of observational evidence. The first work was on the systematics of the shape of DM halos over a wide range in mass, and at different epochs (MNRAS, 367 (2006) 1781). The second work was on comparisons to X–ray observations to test these predictions (MNRAS, 377 (2007) 883). Other work has been on clusters of galaxies (see ApJ 532(2000)206 and ApJ 538(2000)92) and gravitational lensing (see ApJ 533(2000)194 and ApJ 535(2000)555). My work has been funded by the National Science Foundation, the University of Missouri System Research Board, and by Research Awards here at UM - St. Louis. Over the years, I have collaborated on a long-term basis with scientists from around the world to carry out my research. Most recently: Joel Primack @ UCSC (Santa Cruz, USA), and Hernan Quintana @ Universidad Catolica (Santiago, Chile).

PHILIP B. FRAUNDORF

Background and Approach: I'm interested in ways to examine nature on many scales, and how that impacts processes of interest to regional employers as well as problems in nanoscience, Bayesian informatics, and the study of extraterrestrial materials. *Methodology and Tools:* We use atomic-resolution electron microscopes along with other tools for observing, plus mathematical inference to work from these observations toward conclusions about system behavior on various scales of space and time. *Current projects* include the quantitative study of contrast in electron images and diffraction patterns of: (i) unlayered graphene in the core of micron-sized particles formed in the atmosphere of red giants, (ii) implantation damage in silicon wafers used to make bonded silicon on insulator (SOI) devices, (iii) nano particles and single-strand DNA supported by carbon nanotubes, and (iv) ultrahigh temperature ZrB2 ceramics for hypersonic aircraft leading/trailing edges. We are also applying log-probability based multiplicity tools (esp. Kullback-Leibler divergence) to model selection in general, plus to the study of available work in physical systems and layered correlations in more complex systems. *Significance and applications*: Methods development in collaboration with regional researchers has helped put graduates into jobs with private sector employers MEMC Electronic Materials (St. Peters MO), Seagate (Minneapolis), Martin-Marietta (New Orleans), Mitsubishi Silicon America (Portland), Motorola's Digital DNA Lab in Mesa AZ and Cabot Electronics Industries (Napierville IL) along with helping others move to new University assignments here and elsewhere. In the past decade we've provided Missouri researchers their only local access to atomic resolution images, helped inspire establishment of the UM-StL Center for NanoScience, and catalyzed regional nanoalliance meetings in St. Louis, Kansas City, and Columbia MO. The program has also given UM-StL researchers access to a wide range of nano-materials, and tools for addressing challenges in healthcare, energy, biology, engineering, and catalysis.

THOMAS F. GEORGE

Dr. George is involved in theoretical research in several areas of laser/materials/nanophysics. One area involves molecular clusters and nanostructures, where excitation processes in fullerenes by ultrafast laser pulses are being investigated theoretically by numerically solving the Liouville equation for electron density matrices. Comparisons are then carried out with experiments in regard to the control of vibrational excitations. Nonlinear optical responses are considered, where femtosecond and picosecond degenerate and nondegenerate four-wave mixing and pump-probe techniques are used to investigate ultrafast electron and nuclear dynamics, charge transfer and photoexcitation in fullerenes. Another area involves the analysis of diamondoids as possible materials for nanoelectronic devices. A recent venture is in nanomedicine, where laser-induced explosion of absorbing gold nanoparticles in selective nanophotothermolysis of cancer is being explored.

*Recent Publications (January–August, 2011)***:**

- T. F. George, D. Jelski, R. R. Letfullin and G. P. Zhang, Editors, *Computational Studies of New Materials II: From Ultrafast Processes and Nanostructures to Optoelectronics, Energy Storage and Nanomedicine* (World Scientific, Singapore, 2011), 540 pages.

- Z. Sun, Y. P. Xu, S. Li and T. F. George, "Forbidden Singlet Exciton Transitions Induced by Localization in Polymer Light-Emitting Diodes in a Strong Electric Field," *Journal of Physical Chemistry B* 115, 869-73 (2011).
- G. P. Zhang, M. S. Si and T. F. George, "Laser-Induced Spin Protection and Switching in a Specially Designed Magnetic Dot: A Theoretical Investigation," *Europhysics Letters* **94**, 17005-1-6 (2011).
- R. R. Letfullin, C. B. Iversen and T. F. George, "Modeling Nanophotothermal Therapy: Kinetics of Thermal Albation of Healthy and Cancerous Cell Organelles and Gold Nanoparticles," *Nanomedicine: Nanotechnology, Biology, and Medicine* **7**, 137-45 (2011).
- R. R. Letfullin, C. E. W. Rice and T. F. George, "Space Simulations of Thermal Fields Generated in Bone Tissue for Application to Nanophotohyperthermia and Nanophotothermolysis," in *Photonic Therapuetics and Diagnostics VII (Photonics West 2011: BiOS)*, edited by N. Kollias, B. Choi, H. Zeng, H. W. Kang, B. E. Knudsen B. J. Wong, J. F. R. Ilgner, K. W. Gregory, G. J. Tearney, L. Marcu, H. Hirschberg, S. J. Madsen, A. Mandelis, A. Mahadevan-Jansen and E. D. Jansen, *Proceedings of the Society of Photo-Optical Instrumentation* Engineers **7883**, 78834L-1-10 (2011).
- H. C. Jeon, S. J. Lee, T. W. Kang, K. J. Chang, Y. K. Yeo and T. F. George, "Magnetic and Electronic Properties of a Mn Delta-Doping GaN Layer," *Journal of the Korean Physical Society* **58**, 1361-4 (2011).
- L. Gu, S. Li, T. F. George and X. Sun, "Triplet Exciton in Polymeric Electroluminescence," *Physica Status Solidi (b)* **248**, 1490-3 (2011).
- A. V. Zhukov, M. B. Belonenko, M. Paliy and T. F. George, "On the Vortex Stability in BEC," *Journal of Physics B: Atomic, Molecular and Optical Physics* **44**, 165301-1-4 (2011).
- R. R. Letfullin, C. E. W. Rice and T. F. George, "Modeling Photothermal Heating and Ablation of Biological Hard Tissues by Short and Ultrashort Laser Pulses," *International Journal of Theoretical Physics, Group Theory and Nonlinear Optics* **15**, 1-13 (2011).
- G. P. Zhang, D. A. Strubbe, S. G. Louie and T. F. George, "First-Principles Prediction of Optical Second-Harmonic Generation in the Endohedral N@C_{60} Compound," *Physical Review A* **84**, in press (2011).

ERIKA L. GIBB

Star formation takes place in molecular clouds composed of gas and ice-coated dust. As stars form, material forms a disk around the young star from which planetary systems are formed. How the collection of gas and icy dust grains evolves physically and chemically during planet formation is not currently understood. Our solar system has many remnants of this process in the form of comets. Comets retain the volatiles (ices) from the time of formation and when they pass near the Sun, these ices are released and may be studied. Dr. Gibb uses infrared spectroscopy from the 10-meter Keck telescope in Mauna Kea, Hawaii, to study the chemical composition of volatiles in disks around young stars and comets in our own solar system. In particular, she studies the organic composition in these different environments with the goal of learning how prebiotic molecules (molecules important for the development of life) were distributed in the early solar system. She is also interested in understanding how comets may have contributed to Earth's supply of ocean water and organics, potentially a vital step in the origins of life on the early Earth. To address this, she is studying deuterated water toward comets and comparing this to Earth's oceans and formation models of the solar system.

Recent Publications:

- Mumma, M. J., Bonev, B. P., Villanueva, G. L., Paganini, L., DiSanti, M. A., Gibb, E. L., Keane, J. V., and 6 coauthors. "Temporal and Spatial Aspects of Gas Release During the 2010 Apparition of Comet 103P/Hartley 2", Astrophysical Journal, 734, 7, 2011.
- Bonev, B. P., Mumma, M. J., Gibb, E. L., DiSanti, M. A., Villanueva, G. L., Magee-Sauer, K., Ellis, R. S. "Comet C/2004 Q2 (Machholz): Parent Volatiles, a Search for Deuterated Methane, and Constraint on the Methane Spin Temperature", Astrophysical Journal, 699, 1563, 2009.
- Gibb, E., Van Brunt, K. A., Brittain, S. D., Rettig, T. W. "Warm HCN, C_2H_2, and CO in the Disk of GV Tau", Astrophysical Journal, 660, 1572, 2007.
- Gibb, E., DiSanti, M. A., Magee-Sauer, K., Dello Russo, N., Bonev, B. P., Mumma, M. J. "The organic composition of C/2001 A2 (LINEAR)", Icarus, 188, 224, 2007.

PETER H. HANDEL

Dr. Handel continues his research on the Quantum 1/f Effects he introduced, which describe fundamental fluctuations in the physical cross-sections and process rates of Quantum Mechanics, important in most modern high-technology industrial applications, and at Governmental research labs. Support is available for Ph.D. studies in this field. On June 4-6, 2000, and in 2002 he organized together with A.L. Chung, and chaired the 8th and 9th van der Ziel Symposium on "Quantum 1/f Noise and Other Low-Frequency Fluctuations" at UMSL (Sponsored by ONR, AFOSR, ARO and NSF). Dr. Handel also solved the excess heat puzzle in electrolysis. He was an Invited speaker at ICNF'99, 2001, 2003, 2007 and at many recent conferences (he organized and chaired the 12th conference in this series in St. Louis in 1993), and also at several conferences in Europe last year. He served as a member of the "Ultra-low phase noise, high power, GaN HFET-based Generators" MURI at UC-Santa Barbara 2001-2006, and cooperated there with the "MINE" MURI. Finally, Dr. Handel continues his research in the Quantum 1/f Theory and experiment with applications in nanotechnology (he has a Laboratory which is equipped for noise experiments), on his Polarization Catastrophe theory of Atmospheric Electricity, on variants of cold fusion, and on his Maser-Soliton Approach to Ball Lightning, which Dr. Handel has also been directing in Moscow. As the US representative and Executive Committee member in ICBL he organized together with A.L. Chung and chaired the International Symposium on Ball Lightning in 2001. See his web site at www.umsl.edu/~handel containing his General Quantum 1/f Bibliography with contributions from several dozens of other authors to this fundamental new field of science and technology, or new field of quantum mechanics, which he first introduced in 1975. It is practically important for 1/f noise and phase noise in nanotechnology, and in most other high-tech fields of science and engineering, with many successful industrial applications for sensors, quartz and MEMS resonators and sensors, NEMS, SQUIDs, semiconductor devices, mixers, amplifiers, microchips, radar, sonar, lidar, high stability clocks and frequency standards, etc..

Recent Publications:

- Giancarlo Cavalleri and Leonardo Bosi: "Pure 1/f noise: a runaway phenomenon due to the zero-point field (ZPF) of stochastic electrodynamics (SED) Physica A in press. It re-discovers and develops my proof first published in #18, #190, #194 and in part also in # 46 of "Q1/f Bibliography" at www.umsl.edu/~handel. (PAPER BY OTHERS ON QUANTUM 1/F NOISE).
- Peter H. Handel and Amanda M. Truong, "Noise limitations of FET-based biochemical sensors," Proc 20th Intl. Conf. on Noise and Fluctuations, M. Macucci and G. Basso Eds., ICNF'09, ISBN 978-07354-0665-0; ISSN 0094-243X, pp. 187-190.
- A. M. Truong and P. H. Handel, "1/f performance limits of scanning tunneling microscopes," in *Noise and Fluctuations* Proc 20th Intl. Conf. on Noise and Fluctuations, M. Macucci and G. Basso Eds., ICNF'09, ISBN 978-07354-0665-0; ISSN 0094-243X, pp. 69-72.
- P. H. Handel and T. F. George, "1/f Noise Inside a Faraday Cage," Proc 20th Intl. Conf. on Noise and Fluctuations, M. Macucci and G. Basso Eds., ICNF'09, ISBN 978-07354-0665-0; ISSN 0094-243X, pp. 491-494.
- J. Pavelka, N. Tanuma, M. Tacano, J. Šikula and P.H. Handel: Low-Frequency Noise Characteristics of InGaAs/InAlAs Heterostructures, in AIP Conf. Proceedings #1129, "*Noise and Fluctuations*" Proc 20th Intl. Conf. on Noise and Fluctuations, M. Macucci and G. Basso Eds., ICNF'09, ISBN 978-07354-0665-0; ISSN 0094-243X, pp. 183-186.

BOB L. HENSON

Currently, my activities in the Department are mostly in the areas of instruction at the graduate and undergraduate levels plus service in the curriculum area. These activities have been typical for me for most of my professional life. However, I am still active in theoretical research, but at a somewhat reduced level of activity. I am making progress, but my research projects are problems that have remained unsolved by the physics community for a long time, so success will be coming from long shots. My main scholarly activity now is writing a text on topics in theoretical physics at the senior-graduate level. I am approaching this by writing up and expanding my class notes for the many advanced undergraduate and graduate level courses, which I have

taught many times over the past forty-five years. A secondary goal of my writing is that, although I won the 1998 Governor's Award for Excellence in Teaching, it is my expectation that the writing process will make me a better teacher of mathematical physics.

JACOB J. LEVENTHAL

Current effort is directed toward writing a book that is a collection of problems in Classical Mechanics, Electricity & Magnetism, Quantum Mechanics and Statistical Mechanics. It is intended to aid students in their studies of undergraduate and graduate level courses in physics. It could also be used to assist students who are preparing for the PhD qualifying examination. It differs from other compilations of physics problems because it places the problems in the broader context of each subject. It is meant to develop problem solving skills and facilitate understanding of the physics. We stress that the solution of the problem is just the beginning of the learning process. We want the student to ask "what physics can I learn from the problem", not "how can I work this problem and go on to the next one as quickly as possible."

GUOQIANG LI

Dr. Li's research interests include vision care, bioimaging, biophotonics, integrated micro-optoelectronic devices and systems, and information processing. Currently he has an active research program funded by National Institutes of Health, Wallace H. Coulter Foundation, and University of Missouri Research Board. Specifically, the objective is to promote multi-disciplinary research that provides rapid, noninvasive, high resolution imaging tools in biology and medicine, new approaches for detecting and preventing diseases, and innovative technologies for improving vision. Correspondingly, the current effort is devoted to developing next-generation adaptive lens for vision correction. An important feature of such lens is its flexibility in changing the focusing power and correcting high-order aberrations. It involves research in electro-optic materials, design, fabrication, and characterization of the adaptive lenses. Theoretical analysis and experimental demonstration of nanoparticle-doped liquid crystal devices are being investigated. The second focus area is to combine several cutting-edge technologies to develop advanced scanning ophthalmoscope for early diagnosis of eye diseases and characterization of some dynamic behaviors. The third focus of recent research is to investigate biomedical tissue and cell imaging based on confocal, optical coherence tomography, acousto-optic, photoacoustic, and dynamic holographic techniques.

Selected recent publications:

- Choudhary and G. Li, Analysis of nanoparticles in controlling the vertical alignment of nematic liquid crystals, **Photonics West**, San Francisco, Jan. 2012.
- G. Li (invited), Parallel confocal and OCT imaging using adaptive objective lens, **Photonics West**, San Francisco, Jan. 2012.
- G. Li, Adaptive lens, **Progress in Optics 55**, 199-284 (2010).
- G. Li, P. Wang, Local hologram fixing in photorefractive polymers using a CO_2 laser for image display applications, **Appl. Phys. Lett. 96**, 111109 (2010).
- Co-author, An updatable 3D holographic display, **Nature 451**, 694 (2008).
- G. Li, *et al*, High-efficiency switchable flat diffractive ophthalmic lens with three-layer electrode pattern and two-layer via structures, **Appl. Phys. Lett. 90**, 111105 (2007).
- G. Li, *et al*, Switchable electro-optic diffractive lens with high efficiency for ophthalmic applications, **Proc. Natl. Acad. Sci. USA 103**, 6100 (2006).

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JINGYUE (JIMMY) LIU

Dr. Liu is involved in nanoscience and nanotechnology research with a focus on fundamental understanding of nanoscale systems and applications of these nanoscale systems. One area concerns the understanding and

development of nanocatalysts with desirable performance. The development of better nanostructured catalysts can have profound impact on energy production, better usage of resources, reduction of pollutants, environmental control, etc. To understand the synthesis-structure-performance relationships of nanocatalysts, it is critical to understand the surface and interface properties of nanoparticles, which are the main components of nanostructured catalysts, and how they evolve during catalytic reactions. Atomic resolution imaging, nanospectroscopy and microdiffraction techniques, coupled with other surface analysis techniques, are used to characterize nanostructured heterogeneous catalysts. The fundamental insights gained via the study of nanocatalysts can be equally applied to other nanoscale systems. A closely related research area is the study of the physical, chemical and structural properties of novel nanostructures and the application of these nanostructures in: energy harvesting, conversion and storage; sensing chemical and biological molecules; drug or gene delivery; and disease diagnostics. Another research area concerns the development and applications of ultra-high resolution imaging, atomic resolution spectroscopy, small angle X-ray scattering and X-ray diffraction and in situ techniques to characterizing nanoscale systems, especially novel nanostructures and nanostructured systems.

*Recent Publications***:**

- Botao Qiao, Aiqin Wang, Xiaofeng Yang, Lawrence F. Allard, Zheng Jiang, Yitao Cui, Jingyue Liu*, Jun Li* and Tao Zhang*. Single-atom catalysis of CO oxidation using Pt1/FeOx. *NATURE CHEMISTRY* **3**: 634-641, 2011.
- Jingyue Liu*. Advanced electron microscopy of metal–support interactions in supported metal catalysts. *ChemCatChem* **3**: 934–948, 2011.
- Yiqun Zheng, Jing Tao, Hongyang Liu, Jie Zeng, Taekyung Yu, Yanyun Ma, Christine Moran, Lijun Wu, Yimei Zhu, Jingyue Liu, and Younan Xia*. Facile synthesis of gold nanorice enclosed by high-index facets and its application for CO oxidation. *SMALL*. doi: 10.1002/smll.201100106, 2011.
- Hongbo Zhang, Xiulian Pan*, Jingyue (Jimmy) Liu, Weizhong Qian, Fei Wei, Yuying Huang, Xinhe Bao*. Enhanced catalytic activity of sub-nanometer titania clusters confined inside double-wall carbon nanotubes. *ChemSusChem* **4**: 975–980, 2011.
- Mingshang Jin, Hongyang Liu, Hui Zhang, Zhaoxiong Xie, Jingyue Liu and Younan Xia*. Synthesis of Pd nanocrystals enclosed by {100} facets and with sizes <10 nm for application in CO oxidation. *NANO RESEARCH* **4**: 83-91, 2011.
- Byungkwon Lim, Hirokazu Kobayashi, Pedro H. C. Camargo, Lawrence F. Allard, Jingyue Liu* and Younan Xia*. New insights into the growth mechanism and surface structure of palladium nanocrystals. *NANO RESEARCH* **3**: 180-188, 2010
- Jingyue (Jimmy) Liu* and Lawrence F. Allard. Surface channeling in aberration-corrected scanning transmission electron microscopy of nanostructures. *MICROSCOPY & MICROANALYSIS* **16**: 425-433, 2010.

ERIC MAJZOUB

Our group uses the tools of condensed matter physics for the characterization and theoretical modeling of bulk and nano-crystalline materials. We employ a combined experimental and computational approach, utilizing first-principles techniques to understand the electronic, mechanical, and thermodynamic properties of the materials we study.

Currently, our primary research area is hydrogen storage and Li-ion batteries. These materials are of current interest for energy storage and transportation applications. State-of-the-art hydride materials include $NaAlH_4$, $LiAlH_4$, $Ca(BH_4)_2$, and $LiBH_4$. These materials are generally wide gap insulators, and are very different in their material properties from interstitial metal hydrides. The complex hydrides undergo decomposition reactions and have more complicated behavior than the so-called “interstitial” metallic hydrides. The compound $NaAlH_4$

exists as an ionic molecular solid, with AlH_4^- anions bound with polar covalent Al-H bonds. Our group studies the structure, lattice dynamics, and thermodynamic properties of these materials to develop higher hydrogen capacities and better hydrogen sorption kinetics. We also develop Monte Carlo global optimization techniques, using advanced methods, which can predict ground state crystal structures and structures close to the ground state in many of the complex anionic hydrides.

Our work in batteries is focused on Li-ion anode materials, where currently graphitic carbon anodes are limited to about 300 mAhr/g. Our materials show promising results perhaps with 5-10 times the current capacities.
Recent Publications:

- First-principles study of novel conversion reactions for high-capacity Li-ion battery anodes in the Li-Mg-B-N-H system, T. Mason, X. Liu, J.Hong, J. Graetz, E.H. Majzoub, accetped J. Phys. Chem. C, July 2011.
- First-principles calculated phase diagram for nanoclusters in the Na-Al-H system: A single step decomposition pathway for NaAlH4, E.H. Majzoub, Fei Zhou, Vidvuds Ozolins, J. Phys. Chem. C, **115**, 2636 (2011).
- Systematic pore size effects of nanoconfinement of LiBH4: Elimination of diborane release and tunable behavior for hydrogen storage applications, X. Liu, C. Jost, D. Peaslee, T. Baumann, E.H. Majzoub, Chemistry of Materials, **23**, 1331 (2011).
- Theoretical prediction of different decomposition paths for Ca(BH4)2 and Mg(BH4)2, Yongsheng Zhang, E.H. Majzoub, V. Ozolins, C. Wolverton, Phys. Rev. B., **82**, 174107 (2010).
- Improved synthesis of bis(borano)hypophosphite salts., M.R. Anstey, M.T. Corbett, E.H. Majzoub, and J.G. Cordaro, Inorg Chem. **49**(18):8197-9 (2010).
- Controlling the decomposition pathway of LiBH4 via confinement in highly-ordered nanoporous carbon, Xiangfeng Liu, David Peaslee, C.Z. Jost, and E.H. Majzoub, J. Phys. Chem. C, **114**, 14036-14041 (2010).

BRUCE A. WILKING

Using optical and infrared wavelength imaging and spectroscopy, I study the earliest stages in the formation of low mass stars and substellar objects. Most recently, we have embarked on two large optical-wavelength spectroscopic surveys of the surface populations of the Rho Ophiuchi and Serpens molecular clouds using the multi-object spectrographs HYDRA at the WIYN 3.5 meter telescope and HECTOSPEC at the MMT 6 meter telescope. The first results of this study for the Rho Ophiuchi cloud, which allow us to trace the star formation history of the region, appeared in *The Astronomical Journal* in 2005 (v 130, pp. 1733-1751). The follow-up study, accepted for publication in 2011, deals with a larger unbiased sample of young stars from which we derive masses and investigate the distribution of masses for comparison with other regions. Additional spectra for young stars in the Serpens molecular cloud were obtained in the summer of 2010 using the WIYN 3.5 meter telescope and the MMT 6 meter telescope in Arizona, as well as the Magellan 6.5 meter telescope in Chile. These data will be used to study the distribution of masses and ages as well as the kinematics of young stars in the cloud and form the bulk of Kristen Erickson's Ph.D. dissertation. In collaboration with Erika Gibb, I am using multi-epoch data from the Very Long Baseline Array to study the outflows traced by water masers from a young binary system in the Taurus cloud, Haro 6-10. (http://www.umsl.edu/~wilkingb/).

Recent publications:

- Erickson, K., Wilking, B., Meyer, M., Robinson, J., and Stephenson, L. "The Initial Mass Function and Disk Frequency of the Rho Ophiuchi Cloud: An Extinction-Limited Sample", *The Astronomical Journal*, 2011, in press.
- Meyer, M. and Wilking, B. "Infrared Spectra of Young Stars Embedded in the R Coronae Australis Cloud", *Publications of the Astronomical Society of the Pacific*, 121, pp. 350-358, 2009
- Wilking, B., Gagné, M., and Allen, L., "Star Formation in the Rho Ophiuchi Molecular Cloud", in *Handbook of Star Forming Regions, Volume II: The Southern Sky*, ASP Monograph Publications, Vol. 5. Edited by Bo Reipurth, pp.351-381, 2008